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Deferred Taxation and Effective Tax Rates on Income from Capital in the United States, 2000-2010

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Abstract

The accounting and economic literature have long highlighted the potential implications of deferred taxation for tax policy analysis. This paper incorporates deferred taxation into the neoclassical investment model for the computation of the Effective Tax Rate (ETR) on business investment and revisits the empirical evidence on the evolution of ETRs in the United States over the last decade. The numerical results show that after including deferred taxation there is little differential in the ETRs across assets; ETRs in the 2000s have been essentially in line with statutory rates; and partial expensing had little effect on ETRs. These results hold whether investment is financed by equity or debt; profits are distributed to individual shareholders through dividends, interests or capital gains; and regardless of the differential between book and economic depreciation.

Keywords: Deferred taxation, effective marginal tax rates, taxation of income from capital

JEL classification: H3

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1 Introduction

Over the last decade the United States has faced two economic downturns: in the early 2000s following the bust of the dot-com bubble and after the 2007 financial crisis. Corporate tax incentives were provided in both cases in order to promote faster business investment and facilitate the economic recovery for the corporate sector. Both tax stimuli granted at the beginning and end of the 2000s featured temporary increases in tax depreciation allowances for capital spending (partial expensing or, equivalently, bonus depreciation). The 2002 Job Creation and Worker Assistance Act allowed 30 per cent partial expensing for qualified capital equipment with an assumed life of 20 years or less purchased between September 2001 and May 2003. The allowance was increased to 50 per cent by the 2003 Jobs and Growth Tax Relief Reconciliation Act, and then repealed by the end of 2004. The 2008 Economic Stimulus Act reintroduced 50 per cent partial expensing on the cost of depreciable properties acquired in 2008. Subsequently, Section 1201 of the 2009 American Recovery and Reinvestment Act extended the additional 50 per cent first-year depreciation deduction for a further year to assets acquired in 2009.

Neoclassical economic theory states that partial expensing or, more generally, accelerated depreciation increases the rate of investment because, by deferring tax payments to the future, it increases the present value of dividend income distributable to shareholders thus reducing the effective tax burden on income from capital. The empirical literature has also indicated that changes in the effective tax burden on business investment can have significant impacts on investment activity, see Hassett and Hubbard (2002) and, for a review, De Mooij and Ederveen (2003).

In practice, however, high tax depreciation aims to provide firms with extra cash for investment, rather than increase dividend pay-outs. For this reason Generally

Accepted Accounting Principles (GAAP) in the United States, hereafter US GAAP, impose financial constraints on dividend policy to prevent firms from distributing to shareholders any cash-flow arising from the tax deferral generated by tax depreciation. In turn, this implies that the benefit of tax depreciation on investment choices can be significantly overstated by the standard analysis.

The relevance of deferred taxation for corporations in the United States has been long recognized in the empirical accounting literature, which has demonstrated that deferred taxation is the main determinant of the growing gap between the tax and book value of corporation earnings, see Hanlon and Shevlin (2005), and that the gap between book and tax depreciation of business assets is the main source of deferred taxation, see Poterba, Rao, and Seidman (2011). Parallel developments in the economic literature, for example King (1974), Boadway and Bruce (1979) and Kanniainen and Södersten (1995), have demonstrated the relevance of deferred taxation for investment choices and tax policy analysis: a tax policy that introduces accelerated depreciation can indeed decrease current tax liabilities but it also increases deferred tax expenses, thus leaving the total tax liability unchanged. Consequently, tax policy analyses that do not consider simultaneously tax depreciation and deferred taxation can be potentially misleading, see Sørensen (1995).

This paper therefore develops an extension of the standard model for the computation of the Effective Tax Rate (ETR) pioneered by King and Fullerton (1984) and further developed by Gravelle (1994), to incorporate the effect of the deferred tax constraint. The economic literature on deferred taxation and investment choices cited above typically assumes deferred taxation to stem from the gap between economic and tax depreciation. The model developed in this paper, instead, allows the deferred tax constraint to be determined by the gap between the value of business assets for tax and book purposes, thus providing a theoretical assessment of deferred taxation consistent with the US GAAP.

The ETRs derived from the constrained version of the model are then compared with those obtained from the standard theory. It emerges that after considering deferred taxation, ETRs on domestic investment financed by equity and debt show little response to changes in tax depreciation regimes, while they are far more affected by variations in statutory tax rates. Consequently, tax depreciation has also little impact on tax rate differentials across asset types. Furthermore, the deferred tax constraint is demonstrated to be always binding unless book depreciation fully reflects tax depreciation: the ETR is higher (lower) than the statutory rate if book depreciation is lower (higher) than economic depreciation.

Using the dataset employed in the 2006 work of the Congressional Budget Office, hereafter CBO (2006), the paper computes ETRs time series on domestic investment in the United States over the period 2000-2010, starting with a benchmark specification which assumes that the deferred tax constraint depends on the gap between economic and tax depreciation, as postulated by Kanniainen and Södersten (1995).

The empirical results show that the current assessment largely understates the effective tax burden faced by corporations in the United States over the last decade: when considering taxation at the corporate level alone, the constrained model shows that over the last decade the ETR has been on average 35 per cent on investment financed by equity and -21 per cent on investment financed by debt, whereas the standard theory predicts 26 and -38 per cent respectively. This result emerges because the standard assessment considerably overstates the benefit of partial expensing. For example, after accounting for deferred taxation, the 50 per cent partial expensing granted in 2004 and in 2008-2009 reduced the ETR on investment financed by equity only by about 0.3 per cent, while the standard theory predicts a reduction of about 6 per cent. The average 2000-2010 tax rate differential across asset types is negligible under the constrained model, while being about 9 per cent under the standard model. These results hold even when taxation at the individual level is considered: the constrained ETR has been on average over the last ten year close to 40 per cent (the combined statutory rate at corporate-individual tax rate) under equity finance and zero under debt finance, while the standard theory predicts 31 and - 15 per cent respectively.

The paper finally carries out a robustness check of these findings by allowing the deferred tax constraint to depend on the gap between book and tax depreciation. Since there is no information on depreciation rates and methods for financial reporting purposes of the assets used by CBO (2006), the impact of the deferred tax constraint under US GAAP is assessed though a systematic sensitivity analysis: the depreciation method for book purposes of each asset is assumed to be the same as for economic depreciation, while rates of book depreciation are drawn randomly from a uniform distribution. The experiment is repeated for a large number of draws and the ETR computed at each step are then used to determine confidence bands around the benchmark measures of the ETR: it emerges that the difference between the measure of the ETR with and without the deferred tax constraint are statistically significant since the ETR from the unconstrained model never falls within the tunnel constructed using the 90 percent predictive bands. This holds regardless of the form of investment finance and whether or not taxation at the individual level is considered in the benchmark specification.

The paper proceeds as follows. Section 2 describes how corporations in the United States account for deferred taxation and summarises the contribution of the accounting and economic literature in explaining the potential implications of deferred taxation for corporate tax policy analysis. Second 3 provides a non-technical derivation of the marginal ETR under the deferred tax constraint consistent with the US

GAAP. Section 4 compares the new measure of the ETR with those obtained from the standard literature and points out its implications for corporate tax policy analysis. Section 5 quantifies the differences between the constrained and unconstrained measure of the ETRs under the benchmark assumption that the deferred tax constraint depends on the gap between economic and tax depreciation. Section 6 discusses how the interplay between book, tax and economic depreciation affects the ETR and extends the empirical analysis allowing the deferred tax constraint to depend on the gap between book and tax depreciation, as prescribed by US GAAP. Section 7 concludes summarising the main findings of this work. More details on how corporations' earnings are accounted for under US GAAP and the analytical model are provided in Appendices 1 and 2 respectively.

2 The deferred tax constraint on dividend policy

Book accounting differs from tax accounting in the United States, as in most of OECD countries, because of the divergence between the purposes of GAAP for financial reporting and those for Internal Revenue Service tax forms. This gives rise to a gap between the value of assets and liabilities for book and tax purposes. The gap results from either permanent or temporary differences. As documented by Poterba, Rao, and Seidman (2011), permanent differences, which stem from items of revenue and cost disallowed for either tax or financial reporting purposes, are generally a small component of the overall book-tax gap, which is instead mainly driven by temporary differences generated by the intertemporal mismatch between the carrying amount of assets and liabilities for tax and financial accounting.

Deferred taxes are calculated as the product between the tax rate and the change of temporary differences between two subsequent tax years, and under US GAAP corporations must charge them on their income statements. Positive temporary differences generate deferred tax liabilities, i.e. taxes to be paid in the future, which increase the total tax liability of a corporation; negative temporary differences generate deferred tax assets, i.e. credits against current taxes, thus reducing the total tax liability of a corporation. In addition, US GAAP require the recognition in the balance sheet of any deferred tax asset and liability to reflect temporary differences between book and tax income: indeed, under the SFAS No.109, deferred tax provisions are measured as the corporate tax rate on the difference between the book and tax basis of assets and liabilities. This is known as the temporary difference approach. The basic principles of accounting for deferred taxes under the temporary difference approach are illustrated with a numerical example in Appendix 1.

The theoretical implications of deferred taxation for corporations in the United States have been extensively scrutinized in the accounting literature. Sansing (1998) and Guenther and Sansing (2000) demonstrated that deferred taxes are bound to have real effects on corporations whether or not they revert over time since they are directly charged against corporate earnings in the income statement. Mills (2006) highlights the importance of recognizing the significance of the book-tax gap and points out several implications of deferred taxation for corporate policy: for example, corporations with large deferred tax assets are likely to lobby against a tax cut, whereas corporations with net deferred tax liabilities positions are likely to lobby for tax rate cuts. Also, the empirical accounting literature has demonstrated that in the United States the aggregate deferred tax balance for the corporate sector is a liability. This has increased over time, reaching about $400 billion by the end of 2004 and its main driver has been the difference between book and tax depreciation (see Mills and Plesko (2003), Hanlon and Shevlin (2005) and Poterba, Rao, and Seidman (2011)).

The economic effects of deferred taxation on investment choices and corporate tax policy analysis were first outlined in the seminal work on the cost of capital by King (1974). King explains that company law imposes a binding dividend constraint on corporations, designed to comply with the fundamental principle that the share of capital in the economy must be maintained. Early works in the economic literature produced numerous formulations of the deferred tax constraint: King suggested that dividends should be modelled as being limited to current profits plus economic depreciation but net of taxes and interest payments. Boadway and Bruce (1979) and Boadway (1980) proposed that dividends should not exceed the after tax profit, as evaluated for either financial reporting or economic purposes. Sinn (1987) assumes dividend income to be constrained by the after-tax current profit, net of (accelerated) depreciation. Kanniainen and Södersten (1995) demonstrated that the actual form of the deferred tax constraint is ultimately defined by the financial reporting convention to which a corporation must adhere. They pointed out that the constraint required in the United States - as in Sinn's (1997) formulation - imposes that dividends should not exceed the after-tax economic profit, reduced by the tax savings resulting from accelerated depreciation. To the extent that book depreciation equals economic depreciation, the formulation of the deferred tax constraint proposed by Kanniainen and Södersten (1995) is therefore consistent with the temporary differences approach currently required by the US GAAP. The deferred tax constraint, however, creates liquidity in the firm as it increases cash holdings. In Kanniainen and Södersten (1995) model the extra liquidity cannot be distributed to shareholders because of the deferred tax constraint and it cannot be invested in physical capital since it arises at the margin after the optimal capital stock has been reached. Polito (2009) employs Kanniainen and Södersten's (1995) version of the deferred tax constraint to compute ETRs on domestic investment financed by retained earnings implied by the 2008 tax codes of five European countries. The empirical results show that omission of the constraint can result in a significant understatement of the tax burden faced by corporations. In addition, Polito (2009) observes that if a firm does not have an investment project, it can keep its cash holdings in a bank account or purchase financial assets thus earning interest on it. Reinvestment however can only partly mitigate the effect of the deferred tax constraint on dividend policy, since only a small fraction (the after-tax interest rate) of the tax saving generated by accelerated depreciation - rather than the whole tax saving - can still be distributed to shareholders.

3 ETR with deferred taxation

The analytical model used in this paper to calculate ETRs is derived by incorporating deferred taxation into the framework for the computation of marginal ETRs on income from capital pioneered by King and Fullerton (1984) and further developed in the work of Gravelle (1994). In particular, this paper employs the specification of the standard model recently proposed by Burnham and Ozanne (2006), which has been fully endorsed by the Congressional Budget Office in the latest calculation of marginal ETRs on income from capital in the United States, see CBO (2006).[1]

The ETR is defined as the ratio between taxes levied on a hypothetical investment project earning the marginal rate of return and the pre-tax rate return earned by the same project. In a neoclassical investment model, the pre-tax rate of return on the marginal unit of investment corresponds to the user cost of capital, as derived in Jorgenson (1963) and Hall and Jorgenson (1967). The ETR is widely employed for corporate tax policy analysis since it summarizes in a single measure the overall impact on income from capital of statutory tax rates and rules for the determination of the tax base. Traditionally, the latter is captured by the impact of tax depreciation

[1] This section provides a non-technical derivation of the ETR. More details on the analytical model are in Appendix 2.

allowances for capital spending on the return of income from capital. In particular, according to the standard theory, the effective tax burden falls when the tax code grants higher tax depreciation. The incentive works because firms can then defer part of their tax liability to the future, in turn increasing the present value of dividend income distributable to shareholders or, equivalently, reducing the present value of taxes levied on income from capital. Vice-versa, a reduction of tax depreciation allowances has the opposite effect of increasing the ETR. However, as already noted above, US GAAP require the recognition in the income statement of deferred taxes to reflect the temporary difference in tax and book income generated by the gap between tax and book depreciation, thus preventing firms from distributing to shareholders any saving generated by deferred taxation.

To illustrate the derivation of the user cost of capital under US GAAP, consider the example of a competitive firm that increases its capital stock by purchasing a marginal unit of capital in period t. This investment generates a gross rate return $\rho + \delta$, where ρ is the net marginal product of physical capital and δ is the rate of economic depreciation. In the absence of taxation, equilibrium requires the marginal rate of return on the investment to match its opportunity cost, i.e. $\rho+\delta = r-\pi+\delta$, with r denoting the nominal return on financial investment and π the inflation rate. Corporate taxation affects this equilibrium condition in two ways. First, the marginal return on the investment is taxed at the statutory corporate tax rate u. Second, the investment receives a tax depreciation allowance. Suppose ϕ is the depreciation allowance rate, then the firm receives a reduction of its tax liability in period t of $u\phi$, thus implying that the cost of capital falls to $1 - u\phi$. In subsequent periods, the firm continues to receive tax depreciation allowances for the additional investment in period t. Define the present value of these allowances to be z_ϕ, then the cost of capital in net present value is $1 - z_\phi$. As a result of corporate income taxation, the marginal condition for the investment project is thus given by $(\rho_c + \delta)(1-u) = (r_c - \pi + \delta)(1 - uz_\phi)$. Notice that, since the firm can finance its investment with a mix of debt and equity, ρ_c is the real before-tax return required by the firm on a marginal investment financed through a mix of debt and equity, while $r_c = f_c i(1-u) + (1-f_c)(E_c + \pi)$ denotes a weighted-average nominal discount rate, where f_c is the share of investment financed by debt, i is the nominal interest rate on borrowing and E_c is the return on investment financed by retained earnings or new equity issues.[2] In the special case of investment entirely financed by either equity or debt the discount rate reduces to $r_{ce} = (E_c + \pi)$ or $r_{cd} = i(1-u)$ and the user cost of capital is denoted by ρ_{ce} and ρ_{cd} respectively.

Deferred taxation is introduced by noticing that US GAAP require the firm to set capital provisions for the tax saving generated by the tax depreciation allowance. The size of the provision equals the tax rate on the difference between the value of the capital stock for book and tax purposes. As a result, the cost of capital increases in period t by $u(\phi - \alpha)$, with α denoting the book depreciation rate.[3] In present value, the increase in the cost of capital determined by deferred taxation in period t equals $p_t = u(z_\phi - z_\alpha)$, where z_α denotes the present value of book depreciation at the rate α. Resources constrained in provisions for deferred taxes, though undistributable to shareholders, can still be reinvested by the firm in the financial market.[4] Consequently, the cost of capital reduces by the after-tax nominal financial return $r_c(1-u)p_t$. Combining these two elements, the before-tax real rate

[2] The net cost of investment under debt finace is $i(1-u)$, since the cost of borrowing is deductedible from the cost of capital.

[3] Recall that in period t the book value of capital is $1-\alpha$ while the tax value is $1-\phi$, hence the temporary difference is $\phi - \alpha$.

[4] As noted earlier, reinvestment in physical capital is inconsistent with the logic underpinning the original marginal investment choice of the firm, which implies that the firm has already reached the optimal capital stock. A similar assumption can be found in Polito (2009) and Korinek and Stiglitz (2009).

of return required for a marginal investment, ρ_c^*, can be written as

$$\rho_c^* = \frac{(r_c - \pi + \delta)}{(1-u)} \left[1 - uz_\alpha - r_c (1-u) p_t\right] - \delta, \tag{1}$$

where the star is now added to indicate that the computation is carried out under the deferred tax constraint. The difference between ρ_c^* and the after-tax real rate of return savers expect to receive on the marginal savings provided to the firm defines the tax wedge, while the ratio of the tax wedge to the before-tax rate of return is the ETR. There are two typical specifications of the ETR on income from capital when investment is financed with a mix of debt and equity. The first considers taxation at the corporate level only and it is given by

$$ETR_c^* = 1 - \frac{r_c' - \pi}{\rho_c^*}, \tag{2}$$

where $r_c' - \pi = f_c (i - \pi) + (1 - f_c) E_c$ is the real after-tax rate of return paid by the firm, being equal to $i - \pi$ on debt-financed investments and E_c on equity-financed investments. The second specification adds taxation at the individual level, hence resulting in the effective total tax rate

$$ETTR_c^* = 1 - \frac{s_c}{\rho_c^*}, \tag{3}$$

where s_c is the rate of return savers realize after payment of personal income taxes when investment is financed by a mix of debt and equity. The special cases of the ETR at the corporate level on investment entirely financed by either equity (ETR_{ce}^*) or debt (ETR_{cd}^*) are obtained by replacing r_{ce} and r_{cd} in (1) to obtain the corresponding measures of ρ_{ce}^* and ρ_{cd}^* and then substituting these into (2). The corresponding $ETTR_{ce}^*$ and debt $ETTR_{cd}^*$ are obtained after replacing ρ_{ce}^* and ρ_{cd}^*

in (3), as well as the after-tax return received by individuals, which are denoted in each case as s_{ce} and s_{cd}.[5]

4 Deferred taxation and corporate tax policy

Equations (2) and (3) show that the specification of the user cost of capital is crucial in the determination of the ETR on income from capital: given the after-tax rate of return, any tax policy that increases (reduces) the user cost of capital has the effect of increasing (reducing) the ETR. To clarify the implications of deferred taxation for corporate tax policy analysis it is therefore convenient to compare the formulation of the user cost of capital in (1) with those employed in the standard literature.

If the tax liability function does not account for deferred taxation, then $p_t = 0$ and equation (1) reduces to the standard neoclassical formula for the user cost of capital

$$\rho_c = \frac{(r_c - \pi + \delta)}{(1-u)}\,(1 - uz_\phi) - \delta, \tag{4}$$

where the star above ρ_c is now omitted to indicate that the computation abstracts from the deferred tax constraint. The tax policy prescriptions implied by ρ_c are well known. First, an increase in the tax depreciation rate reduces the before-tax real rate return required for a marginal investment, in turn reducing the ETR. In particular, the response of the user cost of capital to an increase of the present value of tax depreciation is measured as

$$\frac{\partial \rho_c}{\partial z_\phi} = -u\frac{(r_c - \pi + \delta)}{(1-u)} < 0. \tag{5}$$

[5] The actual specification of s_c, s_{ce} and s_{cd} mainly depends on the form of investment finance, how saving is taxed at the personal level and the type of account used by the individual shareholder to receive payments from the firm. It is however independent from the specification of the deferred tax constraint. For a full description of these, see either Burnham and Ozanne (2006) or CBO (2006).

Second, a corporate tax rate cut has an ambiguous effect on the ETR since, on the one hand, it increases the user cost of capital by reducing the tax saving generated by tax depreciation but, on the other hand, it reduces the tax charge levied on the marginal rate of return. Third, when tax depreciation equals economic depreciation, the ETR implied by (4) corresponds to the statutory tax rate if investment is entirely financed by equity, $ETR_{ce} = u$, and becomes negative if investment is financed entirely by debt, $ETR_{cd} = -\pi u / \left[i\left(1-u\right) - \pi\right]$. Fourth, in the case of debt financing, the effective total tax rate equals zero, $ETTR_{cd} = 0$. Similarly, ETR_{cd} equals zero when tax depreciation equals economic depreciation and there is not inflation.

Kanniainen and Södersten's (1995) formulation of the user cost of capital under deferred taxation is obtained from equation (1) by assuming that book depreciation reflects economic depreciation and that financial resources accumulated in provisions for deferred taxes are not reinvested: $r_c\left(1-u\right)p_t = 0$. If book and economic depreciation evolve on a declining balance basis at the rate δ, then $z_\alpha = z_\delta = \frac{\delta}{\delta + r_c - \pi}$ and the user cost of capital on investment derived from Kanniainen and Södersten (1995), ρ_c^{KS}, becomes

$$\rho_c^{KS} = \frac{r_c - \pi}{\left(1-u\right)}, \tag{6}$$

which shows that changes in the tax depreciation rate have no effect on the before-tax real rate return required for a marginal investment, $\frac{\partial \rho_{ce}^{KS}}{\partial z_\phi} = 0$, and in turn on the ETR. In particular, in the case of investment financed by equity alone the ETR becomes

$$ETR_{ce}^{KS} = u, \tag{7}$$

which shows that the effective tax burden responds one-for-one to changes in the statutory corporate income tax, regardless of the gap between economic and tax depreciation. When investment is financed by debt, the ETR at the corporate level only becomes

$$ETR_{cd}^{KS} = -\pi u / \left[i \left(1 - u\right) - \pi \right], \tag{8}$$

while after including individual taxation is

$$ETTR_{cd}^{KS} = 0, \tag{9}$$

therefore confirming that corporate tax incentives granted in the form of either accelerated depreciation or partial expensing are entirely ineffective in reducing the tax burden on income from capital. Indeed, this is the same result obtained from the standard model under the assumption that tax depreciation equals to economic depreciation. Furthermore, the equations (7) - (9) show that there is no effective tax burden differential on different asset types, since the ETR under this specification of the deferred tax constraint is independent from the rate of return generated by each asset and its rate of economic depreciation.

Polito (2009) retains the assumption that book depreciation equals economic depreciation, but allows firms to reinvest in the financial market resources accumulated in provisions for deferred taxes. This implies that equation (1) reduces to

$$\rho_c^P = \frac{\left(r_c - \pi + \delta\right)}{\left(1 - u\right)} \left[1 - u z_\delta - r_c \left(1 - u\right) p_t\right] - \delta, \tag{10}$$

with $p_t = u \left(z_\phi - z_\delta\right)$. Using (5) it therefore follows that

$$\frac{\partial \rho_c^P}{\partial z_\phi} = r_c \left(1 - u\right) \frac{\partial \rho_c}{\partial z_\phi},$$

which shows that the omission of the deferred tax constraint has the effect of overstating the benefit from higher tax depreciation on the ETR. This result clearly holds regardless of the form of investment finance.

5 Empirical results

5.1 Data and benchmark specification

The impact of the deferred tax constraint on the ETR in the United States is quantified for the period 2000-2010 using the data for the computation of ETRs provided by the CBO (2006) database.[6] The original dataset includes 53 assets divided into four categories: equipment (32 assets), structures (17), inventories (1) and land (3), of a total value of 32,245 billions of US (2002) dollars; 56 per cent of which is part of business investment. Table 1 summarizes the data used in this paper, which considers only those assets that can benefit from tax depreciation allowances, since only their ETR is affected by deferred taxation. This leaves 46 assets, distinguished between equipment (32) and non-residential structures (14), of a total value of 10,318 billions of dollars, thus covering 57 per cent of the value of business investment in the United States. About 81 per cent of the income generated by these assets is subject to the corporate income tax, while the remaining 19 per cent is subject to the individual tax.

The calculation of the ETRs employs all the assumptions and numerical values for the calibration of the model's parameters used in CBO (2006) and summarized in Burnham and Ozanne (2006). The empirical application compares measures of the ETR obtained with (constrained model) and without (unconstrained model) the deferred tax constraint. ETRs from the unconstrained model, i.e. based on the user cost of capital in equation (4), are therefore consistent with those obtained by CBO (2006). As noted above, the impact of the deferred tax constraint depends on the

[6] The excel spreadsheets with the data along with the companion paper describing the methodology and assumptions employed by CBO (2006) for computing the effective tax rates is freely available at www.cbo.gov.

TABLE 1: ASSETS' DISTRIBUTION BY TYPE AND FORM OF ORGANIZATION

Asset types (number of assets)	Value of stock, $ billions		
	Corporate	Non-corporate	Total
Equipment (32)	3,456	731	4,187
Computers (2)	411	74	484
Communications (3)	606	93	699
Office (6)	223	88	311
Automobiles (1)	117	25	142
Other vehicles (5)	592	101	693
Machinery (8)	627	205	833
Industrial equipment (3)	414	64	479
Other equipment (5)	465	80	546
Structures (14)	4,903	1,228	6,131
Nonresidential (6)	2,914	919	3,834
Mining and drilling (2)	394	33	427
Other structures (6)	1,595	275	1,870
Total (46)	8,359	1,959	10,317
Memo:			
Total Business Investment	18,010		
Total Investment	32,245		

Source: CBO (2006) and author's calculations

gap between book and tax depreciation and how firms use spare cash holdings at the margin. The empirical analysis starts by setting a benchmark specification based on the assumption that book depreciation coincides with economic depreciation and that the liquidity generated by deferred taxation is reinvested in the financial market at the marginal rate. Thus, under the benchmark specification the ETRs are effectively based on the user cost of capital in equation (10). The assumption of book depreciation being equal to economic depreciation provides a plausible benchmark for at least two reasons. First, it is consistent with the standard convention established in the economic literature on tax depreciation and deferred taxation used for the derivation of equation (6). Second, and most importantly, over the past 10 years, accounting standards followed by corporations in the United States, and more generally in the whole OECD area, have increased their flexibility in order to align book depreciation with economic depreciation. Indeed, the IAS 16 (International GAAP 2010) does not prescribe any specific method and/or rate of depreciation for financial reporting, as it requires the depreciation charge to reflect the pattern of consumption of the benefits the assets brings over its useful life, which is essentially consistent with economic depreciation. A qualitative and quantitative assessment of how differences between book and economic depreciation affect the ETR is provided later in section 6.

Since under the benchmark specification the impact of the deferred tax constraint on the ETR depends on the actual gap between tax and economic depreciation, Table 2 documents the magnitude of this gap in the data. The first column reports weighted average rates of economic depreciation for each asset types, $\overline{\delta}$,[7] while the rest of the table reports the ratios (weighted averages for each asset types) of the present value of tax depreciation to the present value of economic depreciation: ratios greater (lower) than 100 indicate that corporations can claim tax depreciation allowances faster (slower) than the assets themselves depreciate, in turn implying that they must also set capital provisions for deferred tax liabilities (assets). The table distinguishes between three forms of investment finance (equity, debt and mix debt-equity) and three depreciation regimes in place during the last decade: permanent law, 30 and 50 per cent partial expensing. The ratios are generally greater than 100 under the permanent depreciation law, and further increase when partial expensing is applied. This is essentially consistent with Poterba, Rao and Seidman's (2011) finding that the aggregate net deferred tax balance of the corporate sector in the United States is a liability, and tax depreciation allowances are its main source. Ratios for structures are in general higher than those for equipment as a result of high tax depreciation deductions allowed on investment in the energy industry. Assets with the highest ratios are those classified under "Other structures", which comprise electric power structures, other power structures, communication structures, railroads, farm

[7] CBO (2006) uses rates of economic depreciation published by the Bureau of Economic Analysis, which are based on the work of Hulten and Wycoff (1981).

structures and other nonresidential structures. This category however accounts for about one-third of the overall value of structures and for about 20 per cent of the overall value of the capital stock subject to the corporate income tax.

TABLE 2: RATIO BETWEEN TAX AND ECONOMIC DEPRECIATION

Asset types	$\overline{\delta}$	Permanent law			30% expensing			50% expensing		
		Equity	Debt	Mix	Equity	Debt	Mix	Equity	Debt	Mix
Equipment	16.2	125	109	119	135	114	127	143	117	132
Computers	44.8	100	99	100	105	101	103	108	102	106
Communications	12.0	126	109	119	136	114	127	142	117	132
Office	13.8	124	108	118	133	112	125	139	115	129
Automobiles	33.3	102	99	101	108	102	105	111	104	108
Other vehicles	12.0	137	115	128	147	119	136	154	122	141
Machinery	12.6	126	110	120	135	114	127	142	117	132
Industrial equipment	10.4	133	112	125	143	117	133	150	120	138
Other equipment	8.8	126	109	120	150	120	138	166	126	150
Structures	2.9	141	117	134	158	123	145	169	127	153
Nonresidential	2.7	104	97	103	104	97	103	104	97	103
Mining and drilling	7.2	166	128	151	176	132	158	183	134	163
Other structures	2.2	212	155	193	264	174	230	299	186	255
Total	8.3	135	113	128	149	119	138	158	123	145

Notes: $\overline{\delta}$=Economic depreciation rates, weighted average for each asset type.
Source: CBO (2006) and author's calculations.

5.2 Taxation at the corporate level

The evolution of the ETR on business investment in the United States for the period 2000-2010 obtained under the benchmark specification of the model, when investment is subject to taxation at the corporate level alone, is reported in Figure 1. As in CBO (2006), the main parameters, in percentages, are calibrated as follows: the corporate tax rate (u) is 35, inflation (π) is 1.8, the nominal rate ($i = r'_{cd}$) is 7.2, the return on equity investment ($E_c = r'_{ce} - \pi$) is 7, and the share of investment financed by debt (f_c) is 41. Rates of economic depreciation and present values of tax depreciation on different asset types were summarized in Table 2.

Since the top statutory corporate tax rate has been held constant at 35 per cent over the last decade, changes in tax depreciation are the only factor determining variations of the ETR in the constrained and unconstrained models: as noted in the introduction the permanent depreciation law is applied in the year 2000 and from 2005 to 2007, the 30 per cent partial expensing from 2001 to 2003, whereas the 50 per cent partial expensing is applied in 2004 and 2008-2009.

The ETRs in Figure 1 are weighted averages on investment in equipment (left panels) and structures (right panels) when the source of finance is either equity (top panels) or debt (bottom panel). In the case of equity finance, the ETR from the constrained model on investment in both equipment and structures is positive but close to the statutory tax rate and display little response to changes in tax depreciation over the whole 2000-2010 period. In sharp contrast, the ETR from the unconstrained model is still positive but well below the statutory tax rate. This measure of the ETR falls in particular in the early and late 2000s, when the tax code provided bonus depreciation.[8]

When investment is financed by debt alone, the ETR computed from both models is negative, as a result of the double incentive resulting from the deduction of interest payments and high tax depreciation: the ETR measured from the constrained model is relatively stable over time and just below -20 per cent, whereas the ETR obtained from the unconstrained model is far lower and reduces considerably when firms can claim bonus depreciation.

[8] The ETR on equipment is in general lower than that on structures because the user cost of capital is computed net of the rate of economic depreciation, see equation (4), which is on average greater for equipment than structures, see Table 2.

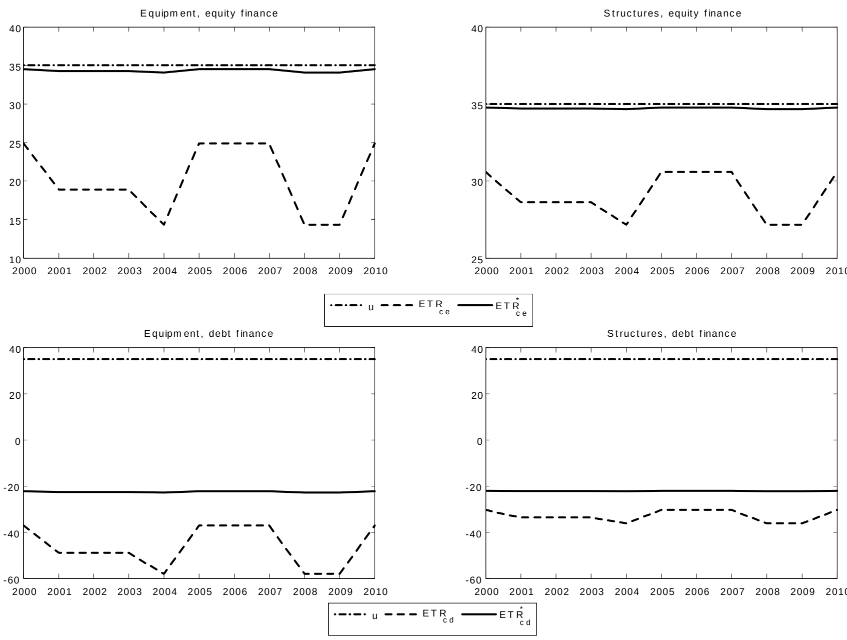

Figure 1: ETRs on business investment in the United States, 2000-2010. Taxation at the corporate level

Table 3 provides a numerical assessment of these results. The constrained model (top panel) suggests that the ETR does not respond significantly to changes in tax depreciation, being on average equal to 34.5 per cent under equity finance, -22.3 per cent on debt financed investment, and about 22.5 per cent on investment financed through a debt-equity mix. In addition, it is evident that the ETR differential across asset types is almost negligible, and only marginally affected by changes in the depreciation regime: the standard deviation of the ETR across assets is below 0.4 per cent regardless of the form of investment finance and the depreciation regime. Note that in the absence of reinvestment, the ETR from the constrained model is for all assets equal to 35 per cent on investment financed by equity, -21.87 on debt-financed investment and 22.35 when investment is financed by the assumed debt-equity mix.[9]

[9] These are derived by replacing in equation (2) the user cost of capital obtained in (7) and (8).

As these rates are valid irrespective of the type of asset, the ETR differential is therefore zero in the absence of reinvestment. The unconstrained model (bottom panel) instead predicts significant declines of the ETR under partial expensing: on average across all type of assets and for investment financed through a mix of debt and equity, the ETR declines by about 4 per cent under the 30 per cent bonus depreciation and by a further 3 per cent under 50 per cent expensing. The decline is larger for investment in equipment and under debt finance. The unconstrained model also shows a significant ETR differential among different types of assets, which increases under partial expensing: the standard deviation of the ETR across assets is 5.7, 12.6 and 7.1 per cent for investment financed by equity, debt and mix debt-equity respectively under the permanent depreciation law. This increases to 7.1, 13.9 and 8.5 respectively under 50 per cent partial expensing.

5.3 Taxation at the corporate and individual level

Corporations can pass the after-tax return on business investment to individual shareholders either directly through payments of dividends and interests or indirectly by reinvesting profits and generating capital gains. Dividends, interests and capital gains are subject to the individual income tax when received by individual shareholders. The impact of this further level of taxation in general depends on the statutory tax rates levied under the individual income tax; the relief for the double taxation at the corporate and individual level of capital income granted by the tax system; and whether the dividend, interest or capital gain is supplied through either a nontaxable, or a temporarily deferred or fully taxable account.[10] Taxation at the individual level

[10] As in CBO (2006) the calibration assumes that interest income is supplied through accounts that are fully taxable by 46 per cent, temporarily deferred by 21.3 per cent and nontaxable by 32.7 per cent. These percentages change to 58.4, 5.8 and 35.8 per cent respectively for equity income. It is also assumed that 57.14 per cent of the real equity return is paid as dividend while the rest is reinvested and paid as capital gain.

TABLE 3: EFFECTIVE TAX RATES ON BUSINESS INVESTMENT IN THE UNITED STATES, CORPORATE TAXATION ONLY									
Asset types	Permanent law			30% expensing			50% expensing		
	Equity	Debt	Mix	Equity	Debt	Mix	Equity	Debt	Mix
Constrained model									
Equipment	34.5	-22.3	21.9	34.3	-22.5	21.6	34.1	-22.7	21.5
Computers	35.0	-21.6	22.4	34.6	-22.1	22.0	34.3	-22.4	21.7
Communications	34.4	-22.4	21.8	34.2	-22.6	21.6	34.1	-22.8	21.4
Office	34.4	-22.4	21.8	34.2	-22.6	21.6	34.1	-22.8	21.4
Automobiles	34.9	-21.7	22.3	34.5	-22.2	21.9	34.3	-22.4	21.7
Other vehicles	34.3	-22.5	21.7	34.1	-22.7	21.5	34.0	-22.8	21.4
Machinery	34.4	-22.4	21.8	34.2	-22.6	21.6	34.0	-22.8	21.4
Industrial equipment	34.4	-22.5	21.7	34.2	-22.7	21.5	34.0	-22.8	21.4
Other equipment	34.6	-22.2	22.0	34.4	-22.5	21.7	34.2	-22.7	21.5
Structures	34.8	-22.1	22.1	34.7	-22.1	22.1	34.7	-22.2	22.0
Nonresidential	35.0	-21.8	22.3	35.0	-21.8	22.3	35.0	-21.8	22.3
Mining and drilling	34.1	-22.8	21.5	34.0	-22.9	21.4	33.9	-23.0	21.3
Other structures	34.5	-22.4	21.9	34.3	-22.6	21.7	34.2	-22.7	21.5
Total	34.7	-22.2	22.0	34.5	-22.3	21.9	34.4	-22.4	21.8
Unconstrained model									
Equipment	24.9	-37.0	10.4	18.9	-48.9	3.3	14.3	-58.1	-2.2
Computers	34.5	-13.3	23.1	26.9	-28.5	13.9	20.9	-41.1	6.5
Communications	23.3	-40.6	8.4	17.5	-52.0	1.5	13.2	-60.7	-3.7
Office	23.1	-40.5	8.3	17.4	-51.9	1.5	13.1	-60.6	-3.7
Automobiles	32.8	-17.0	20.9	25.5	-31.9	12.0	19.6	-44.1	4.8
Other vehicles	20.9	-46.1	5.4	15.7	-56.4	-0.8	11.7	-64.1	-5.5
Machinery	22.8	-41.5	7.8	17.1	-52.7	1.1	12.9	-61.2	-4.0
Industrial equipment	21.9	-44.2	6.6	16.4	-54.9	0.0	12.3	-63.0	-4.9
Other equipment	28.1	-32.2	14.1	21.5	-45.0	6.2	16.4	-55.1	0.1
Structures	30.6	-30.2	16.7	28.6	-33.6	14.4	27.2	-36.1	12.8
Nonresidential	34.7	-20.3	22.1	34.7	-20.3	22.1	34.7	-20.3	22.1
Mining and drilling	15.0	-60.0	-2.1	11.0	-67.3	-6.8	8.1	-72.6	-10.1
Other structures	25.6	-43.6	9.9	20.1	-53.1	3.6	15.9	-60.2	-1.2
Total	28.3	-33.0	14.2	24.7	-39.8	9.9	21.9	-45.0	6.7
Source: Authors' calculations									

does not alter the impact of deferred taxation on the user cost of capital, but results in a higher tax burden on the rate of return realized by savers. Indeed, under the standard calibration of the model employed by CBO (2006) the after-tax returns realized by savers used in equation (3) are (s_{ce} =) 6.26 for equity-financed investment, (s_{cd} =) 4.49 for debt-financed investment and (s_c =) 5.53 for investment financed with a debt-equity mix, which are lower than the real after-tax rates of return - r'_{ce}, r'_{cd} and r'_c - paid by the firm in the case of taxation at the corporate level only.

The evolution of the ETRs on business investment after considering taxation at the corporate and individual level is presented in Figure 2. The computation of the ETRs takes into account that the 2003 Jobs and Growth Tax Relief Reconciliation Act reduced to 15 per cent the statutory tax rates on dividends and capital gains, and maintains these lower rates until 2010. This has the effect of increasing the after tax return realized by individual savers under equity finance, thus resulting in s_{ce} =6.44 and s_c =5.63.

Taxation at the individual level evidently increases the ETR regardless of the type of investment asset and form of finance. The constrained model shows that after including taxation at the individual level the ETR on equity financed investment increases above the statutory corporate tax rate. This ETTR had a significant decline only in 2003 as a result of the reduced individual tax rates on dividend income and capital gains, while remaining fairly stable in the other periods. This therefore corroborates the previous finding that the effective tax burden is essentially determined by changes in tax rates, rather than depreciation allowances. The ETTR on debt financed investment is instead close to zero throughout the whole 2000-2010 period. As for the case of taxation at the corporate level alone, there are not significant differences in the ETRs on equipment and structures.

These results are in sharp contrast with those obtained from the standard model, which suggests that when investment is financed by equity the ETTR on equipment is still below the statutory corporate tax rate under the permanent depreciation law and further decreases under partial expensing, whereas the ETTR on structures is lower than the statutory corporate tax rate only under bonus depreciation. The standard model also suggests that taxation at the individual level only partially offsets the benefit from high tax depreciation and the deduction of the cost of capital, since the ETTR on debt financed investment is still predicted to be well below zero. Visual inspection clearly shows that ETRs differentials across asset types remains significant even after inclusion of taxation at the individual level.

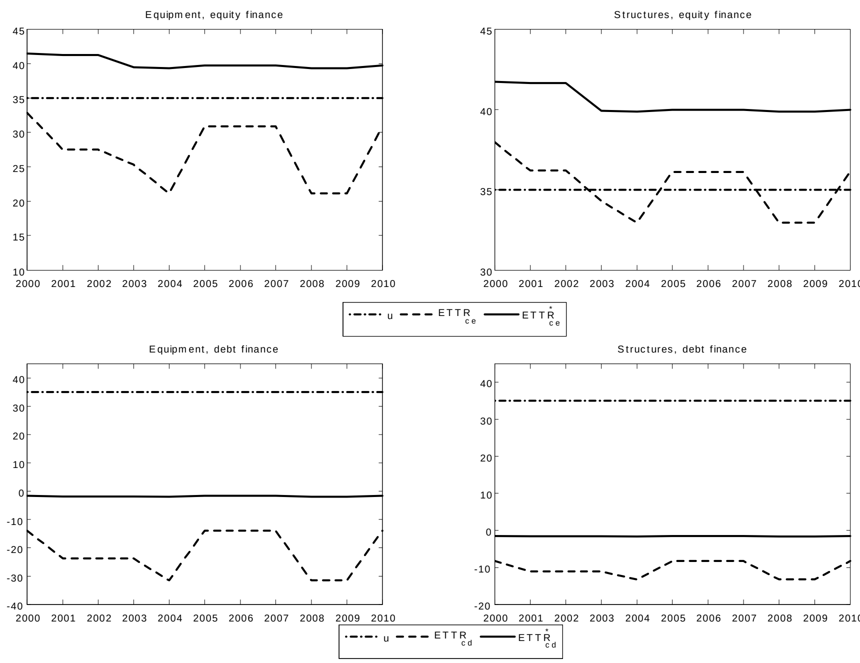

Figure 2: ETRs on business investment in the United States, 2000-2010. Taxation at the corporate and individual level

Numerical values of the ETTRs under individual taxation before and after the 2003 reduced rates on dividend income and capital gains are summarized in Tables 4 and 5 respectively. Compared to the case of taxation at the corporate level alone, the ETTRs increase in the constrained model from 34.7 to 41.6 per cent on equity finance and from -22 to -1.5 per cent for debt finance, resulting in an average increase across all type of assets under the mixed debt-equity finance of about 10 per cent, regardless of the tax depreciation regime. The unconstrained model predicts increases in the ETTR of about 8, 23 and 11 per cent for investment financed by equity, debt and debt-equity mix respectively. Both models suggest that the reduced rates on dividend income and capital gains introduced in 2003 resulted in a fall of the average ETTR of about 2 and 1.5 per cent depending on whether investment is fully or only partially financed with equity. Most notably, introduction of taxation at the individual level does not alter the previous finding that the ETR is far more stable over time than predicted by the standard theory and that ETRs across different assets are in practice negligible: the standard deviation of the ETTRs obtained from the constrained model reported in both Tables 4 and 5 is never higher than 0.5 per cent, regardless of the form of investment finance and the depreciation regime; whereas for the unconstrained model it is 5.73, 11.78 and 7.02 per cent under the permanent depreciation law when investment is financed by equity, debt and the debt-equity mix respectively, rising to 6.56, 12.05 and 7.73 per cent respectively under the 50 per cent partial expensing. Finally note that, if computed in the absence of reinvestment, the ETTRs from the constrained model would be equal to 41.91 per cent under equity finance and 0 under debt finance for all assets. The ETTR on equity financed investment would fall to 40.2 after considering the 2003 rate reduction.

6 Book vs. economic depreciation

The benchmark specification of the empirical model for the computation of the ETRs assumed that deferred taxation depended on the gap between economic and tax depreciation. However, the deferred tax constraint under US GAAP is ultimately determined by the difference between book and tax depreciation, as disclosed in the formulation of the user cost of capital in equation (1).

To illustrate how the interplay between tax, book and economic depreciation affects the ETR, it is convenient to re-write the user cost of capital in equation (1) as

TABLE 4: EFFECTIVE TOTAL TAX RATES ON BUSINESS INVESTMENT IN THE UNITED STATES UNDER CORPORATE AND INDIVIDUAL TAXATION BEFORE 2003

Asset types	Permanent law			30% expensing			50% expensing		
	Equity	Debt	Mix	Equity	Debt	Mix	Equity	Debt	Mix
Constrained model									
Equipment	41.5	-1.6	31.9	41.2	-1.9	31.7	41.1	-2.0	31.5
Computers	41.9	-1.1	32.3	41.5	-1.5	32.0	41.3	-1.7	31.8
Communications	41.4	-1.7	31.8	41.2	-1.9	31.6	41.1	-2.1	31.5
Office	41.4	-1.7	31.8	41.2	-1.9	31.6	41.1	-2.1	31.5
Automobiles	41.8	-1.2	32.2	41.5	-1.6	31.9	41.3	-1.8	31.7
Other vehicles	41.3	-1.8	31.7	41.1	-2.0	31.6	41.0	-2.1	31.5
Machinery	41.4	-1.7	31.8	41.2	-1.9	31.6	41.1	-2.1	31.5
Industrial equipment	41.3	-1.8	31.8	41.2	-2.0	31.6	41.0	-2.1	31.5
Other equipment	41.6	-1.6	32.0	41.3	-1.8	31.8	41.2	-2.0	31.6
Structures	41.7	-1.5	32.1	41.7	-1.5	32.0	41.6	-1.6	32.0
Nonresidential	41.9	-1.3	32.3	41.9	-1.3	32.3	41.9	-1.3	32.3
Mining and drilling	41.1	-2.1	31.5	41.0	-2.2	31.4	40.9	-2.2	31.4
Other structures	41.5	-1.8	31.9	41.3	-1.9	31.7	41.2	-2.0	31.6
Total	41.6	-1.5	32.0	41.5	-1.7	31.9	41.4	-1.8	31.8
Unconstrained model									
Equipment	32.9	-13.9	21.9	27.5	-23.8	15.7	23.4	-31.4	10.9
Computers	41.4	5.8	32.9	34.7	-6.8	24.9	29.3	-17.3	18.4
Communications	31.4	-16.9	20.1	26.3	-26.4	14.1	22.4	-33.6	9.6
Office	31.3	-16.8	20.1	26.2	-26.3	14.1	22.3	-33.5	9.6
Automobiles	40.0	2.7	31.1	33.4	-9.7	23.3	28.2	-19.8	17.0
Other vehicles	29.3	-21.4	17.6	24.6	-30.0	12.1	21.1	-36.5	8.0
Machinery	31.0	-17.7	19.6	25.9	-27.0	13.7	22.1	-34.1	9.3
Industrial equipment	30.2	-19.9	18.5	25.3	-28.8	12.8	21.6	-35.5	8.6
Other equipment	35.8	-9.9	25.1	29.9	-20.6	18.2	25.3	-28.9	12.9
Structures	38.0	-8.2	27.4	36.2	-11.1	25.4	34.9	-13.2	23.9
Nonresidential	41.7	0.0	32.1	41.7	0.0	32.1	41.7	0.0	32.1
Mining and drilling	24.0	-33.0	11.0	20.5	-39.1	6.9	17.9	-43.5	4.0
Other structures	33.5	-19.4	21.4	28.6	-27.3	15.9	24.9	-33.2	11.8
Total	35.9	-10.6	25.2	32.7	-16.2	21.4	30.2	-20.6	18.6

Source: Author's calculations

$$\rho_c^* = \rho_c + \Delta \left(z_\phi - z_\alpha \right),$$

where ρ_c is defined in (4) and $\Delta = \frac{(r_c - \pi + \delta)}{(1-u)} \left[1 - r_c \left(1 - u\right)\right]$ measures the bias in the user cost of capital (ETR) caused by the omission of the deferred tax constraint. Since Δ is always positive, it follows that $\rho_c^* \gtreqless \rho_c$ if $\phi \gtreqless \alpha$. In other words, the deferred tax constraint is always binding, unless tax depreciation equals book depreciation. The rate of book depreciation in terms of the economic depreciation rate can be

TABLE 5: EFFECTIVE TOTAL TAX RATES ON BUSINESS INVESTMENT IN THE UNITED STATES UNDER CORPORATE AND INDIVIDUAL TAXATION AFTER 2003

Asset types	Permanent law			30% expensing			50% expensing		
	Equity	Debt	Mix	Equity	Debt	Mix	Equity	Debt	Mix
Constrained model									
Equipment	39.7	-1.6	30.5	39.5	-1.9	30.3	39.4	-2.0	30.2
Computers	40.2	-1.1	31.0	39.8	-1.5	30.6	39.6	-1.7	30.4
Communications	39.7	-1.7	30.5	39.5	-1.9	30.3	39.3	-2.1	30.1
Office	39.7	-1.7	30.5	39.4	-1.9	30.3	39.3	-2.1	30.1
Automobiles	40.1	-1.2	30.9	39.7	-1.6	30.6	39.5	-1.8	30.4
Other vehicles	39.6	-1.8	30.4	39.4	-2.0	30.2	39.3	-2.1	30.1
Machinery	39.6	-1.7	30.5	39.4	-1.9	30.3	39.3	-2.1	30.1
Industrial equipment	39.6	-1.8	30.4	39.4	-2.0	30.2	39.3	-2.1	30.1
Other equipment	39.9	-1.6	30.7	39.6	-1.8	30.4	39.4	-2.0	30.2
Structures	40.0	-1.5	30.8	39.9	-1.5	30.7	39.9	-1.6	30.7
Nonresidential	40.2	-1.3	30.9	40.2	-1.3	30.9	40.2	-1.3	30.9
Mining and drilling	39.4	-2.1	30.2	39.2	-2.2	30.1	39.2	-2.2	30.0
Other structures	39.8	-1.8	30.5	39.6	-1.9	30.3	39.4	-2.0	30.2
Total	39.9	-1.5	30.7	39.8	-1.7	30.6	39.7	-1.8	30.5
Unconstrained model									
Equipment	30.9	-13.9	20.4	25.3	-23.8	14.0	21.1	-31.4	9.1
Computers	39.7	5.8	31.6	32.8	-6.8	23.4	27.2	-17.3	16.8
Communications	29.4	-16.9	18.6	24.1	-26.4	12.4	20.1	-33.6	7.8
Office	29.3	-16.8	18.5	24.0	-26.3	12.4	20.0	-33.5	7.8
Automobiles	38.2	2.7	29.7	31.4	-9.7	21.8	26.0	-19.8	15.4
Other vehicles	27.2	-21.4	15.9	22.4	-30.0	10.3	18.8	-36.5	6.2
Machinery	28.9	-17.7	18.0	23.7	-27.0	12.0	19.8	-34.1	7.5
Industrial equipment	28.1	-19.9	16.9	23.1	-28.8	11.1	19.3	-35.5	6.8
Other equipment	33.9	-9.9	23.6	27.8	-20.6	16.6	23.1	-28.9	11.1
Structures	36.1	-8.2	25.9	34.3	-11.1	23.9	33.0	-13.2	22.4
Nonresidential	39.9	0.0	30.7	39.9	0.0	30.7	39.9	0.0	30.7
Mining and drilling	21.8	-33.0	9.2	18.1	-39.1	5.1	15.4	-43.5	2.1
Other structures	31.5	-19.4	19.9	26.5	-27.3	14.3	22.7	-33.2	10.0
Total	34.0	-10.6	23.7	30.7	-16.2	19.9	28.2	-20.6	17.0

Source: Author's calculations

written as $\alpha = \delta(1+\gamma)$, where γ measures the difference between book and economic depreciation as a proportion of the economic depreciation rate: if $\gamma > (<)0$, then book depreciation is greater (lower) than economic depreciation. It then follows that

$$\rho_c^* = \rho_c + \Delta\left(z_\phi - z_\delta - z_{\delta\gamma}\right),$$

where $z_{\delta\gamma} = \frac{\delta\gamma}{\delta\gamma + r_c - \pi}$, which shows that unless $z_\gamma = z_\phi - z_{\delta\gamma}$, i.e. book depreciation equals tax depreciation, the constraint is always binding. The actual effect of the constraint depends upon γ. If $\gamma < 0$, then book depreciation is more conservative relative to economic depreciation and the negative bias on the user cost of capital increases. Vice-versa, if $\gamma > 0$, then book depreciation is more aggressive than economic depreciation, and the negative bias reduces.

This shows that a correct measurement of the ETR on income from capital requires detailed information on methods and rates of assets' depreciation for both book and economic purposes, which is currently lacking for the assets used in table 1. In general, rates and methods of book depreciations are likely to differ across industries and to change over long period of times. Basu (1997) and Givoly, Hayn, and Natarajan (2007) suggest that they are also likely to change over the business cycle, with accounting conservatism increasing ($\gamma > 0$) during expansions and reducing ($\gamma < 0$) during recessions.

Although the accounting literature has pointed out that accounting conservatism may result in aggressive depreciation policies ($\gamma > 0$), thus leading to an understatement of book profits, there is no systematic empirical evidence of accounting conservatism across corporations in the United States. A recent study by Easton and Pae (2004) concludes that "there is no evidence of conservatism associated with over-depreciation" for the corporate sector in the United States. The authors report a negative value of γ for the aggregate corporate sector, but this is statistically insignificant at the conventional level. When scrutinized across different industries, the value of γ is positive and statistically significant for durable manufacturers, negative and statistically significant for pharmaceutical, while no statistically significant $\gamma \neq 0$ is found in all other industries. Easton and Pae (2004) also find evidence that conservatism decreases during downturns, as the value of γ becomes negative and statistically significant for firms with negative returns.

This evidence suggests that equation (6) is likely to provide benchmark measures of the ETR which accurately describe the evolution of the effective tax burden in the United States over the last 10 years. Nevertheless, the likely impact of the difference between book and economic depreciation on the ETR can be assessed through prior predictive analysis.[11] The assessment works as follows. Let α_i be an unknown structural parameter denoting the rate of book depreciation of the asset $i = 1, ..., T$. Define $ETR_k^* (\breve{\alpha}_i)$ and $ETTR_k^* (\breve{\alpha}_i)$ as the measures of the ETR on the asset i under finance $k = ce, cd$ and c, obtained from the model given a specific realization of the parameter $\alpha_i = \breve{\alpha}_i$. Assume that α_i is uniformly distributed over the interval $\Theta = \delta_i (1 \pm \gamma)$, where δ_i denotes the rate of economic depreciation of the assets i and the parameter γ measures the excess of book depreciation over economic depreciation. Draw $\breve{\alpha}_i^d$ from Θ for each $i = 1, ..., T$; compute the $ETR_k^* \left(\breve{\alpha}_i^d\right)$ and $ETTR_k^* \left(\breve{\alpha}_i^d\right)$ for each draw $d = 1, ..., D$, for each $i = 1, ..., T$, and for each $k = ce, cd, c$; and order the resulting ETRs increasingly. These can then be used to compute confidence bands for the ETRs at any specified confidence level.

The ETRs on business investment taxed at both corporate and corporate-individual levels, simulated for $T = 49$, $\gamma = 0.5$, $D = 10000$ and at the 10 per cent confidence level, are presented in Figures 3 and 4 respectively. The simulation shows that allowing book depreciation to differ from economic depreciation clearly adds a degree of uncertainty on the actual measure of the ETR obtained from the constrained model: the upper confidence bands measure the ETR when book depreciation is more conservative than economic depreciation ($\gamma < 0$), whereas the lower confidence band occurs when book depreciation is more aggressive than economic depreciation ($\gamma > 0$). The results show that the ETR from the constrained model is higher than

[11] Prior predictive analysis is widely employed for model evaluations in statistics, engineering and economics. For a more detailed description see Canova (2007).

that predicted from the unconstrained model and the difference is statistically significant, regardless of the category of investment asset (equipment or structures), the form of investment finance (debt or equity) and whether the model accounts for taxation at the individual level.

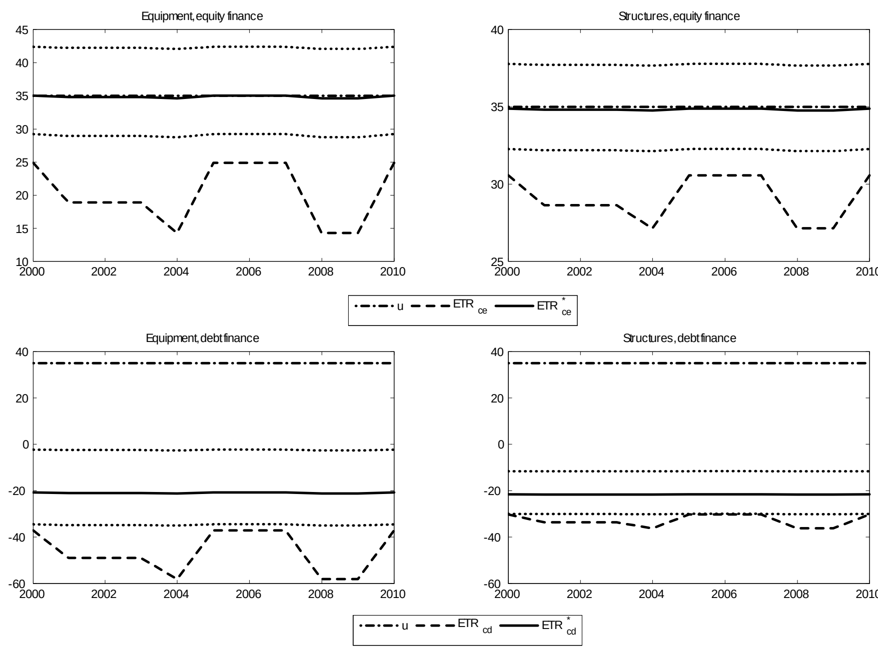

Figure 3: ETRs on business investment in the United States with 90 per cent confidence bands (dotted lines), 2000-2010. Book depreciation differs from economic depreciation. Taxation at the corporate level

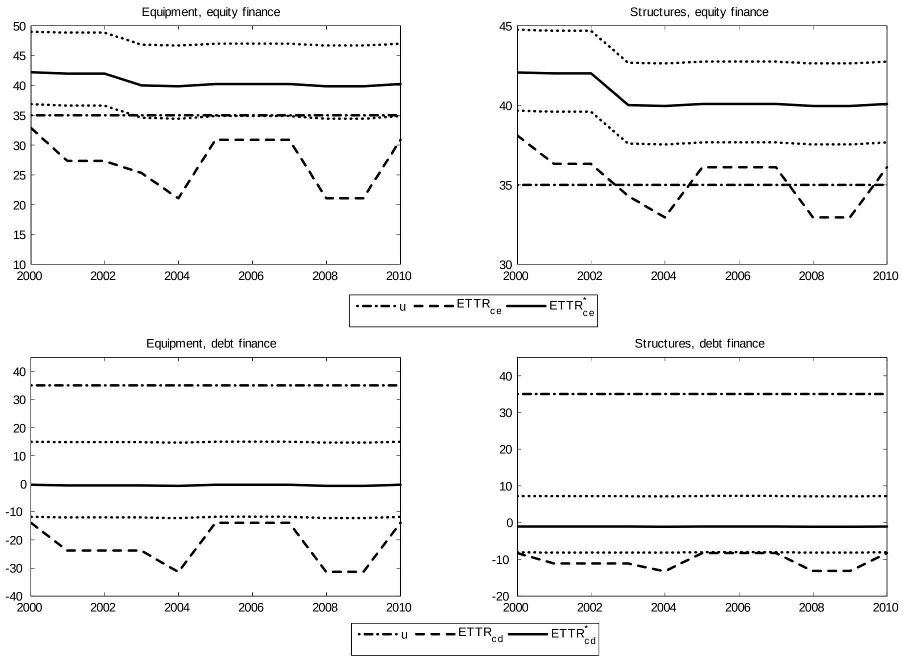

Figure 4: ETRs on business investment with 90 per cent confidence bands (dotted lines) in the United States, 2000-2010. Book depreciation differs from economic depreciation. Taxation at the corporate and individual level

Table 6 summarises these results by reporting the average values of the ETRs on business investment in the United States over the period 2000-2010 obtained from the two models. Since partial expensing has little impact on the effective tax burden after accounting for the deferred tax constraint, ETRs have been essentially close to headline statutory rates on equity financed investment over the last decade. Debt financing has clearly the effect of reducing the tax burden, but the investment subsidy provided by the deduction of the cost of capital is far lower than that predicted by the standard theory. Over the last decade, the average ETRs differential across asset types has been almost zero. Even after allowing for a systematic mismatch between accounting and economic depreciation, which finds not support in the empirical accounting literature, the ETR is significantly higher than that predicted by the standard theory. The gap between the measures of the tax burden obtained from the two models is likely to rise during periods of downturns or recession since on the one hand partial expensing reduces the conventional measure of the ETR, and, on the other hand, the constrained measure is likely to tend towards its upper bound.

TABLE 6: ETRs ON BUSINESS INVESTMENT IN THE UNITED STATES, AVERAGE 2000-2010

	Equity		Debt		Mix	
	Corporate taxation only					
	ETR^*_{ce}	ETR_{ce}	ETR^*_{cd}	ETR_{cd}	ETR^*_{c}	ETR_{c}
Equipment	35 (42,29)	20	-21 (-2,-35)	-46	22 (32,15)	5
Structures	35 (38,32)	29	-22 (-12,-30)	-33	22 (27,18)	15
Total	35 (40,31)	26	-21 (-8,-32)	-38	40 (47,35)	27
	Corporate and individual taxation					
	$ETTR^*_{ce}$	$ETTR_{ce}$	$ETTR^*_{cd}$	$ETTR_{cd}$	$ETTR^*_{c}$	$ETTR_{c}$
Equipment	40 (47,35)	27	-1 (15-12)	-21	31 (40,24)	16
Structures	40 (43,38)	35	-1 (7-8)	-10	31 (30,28)	24
Total	40 (44,36)	31	-1 (10-10)	-15	31 (37,26)	21

Note: Upper and lower 90 per cent confidence bands are reported in brackets.
Source: Author's calculations

7 Conclusion

This paper merges the traditional neoclassical literature on corporate taxation and investment choices with the more recent literature on the impact of the deferred tax constraint stemming from US GAAP on dividend policy and the cost of capital. The theoretical importance of recognizing the deferred tax constraint for corporate tax policy analysis has been outlined by several authors, for example, Sørensen (1995) and more recently Mills (2006) and Plesko (2006) among others, and this paper effectively investigates the empirical relevance of these constraints by examining their effect on the corporate tax burden face by corporations in the United States.

The paper thus incorporates the dividend policy constraint stemming from the deferred taxation generated by tax depreciation, as prescribed by the US GAAP, into the CBO (2006) model for computing the ETRs. This new framework is then used to recalculate marginal ETRs on business investment in the United States over the last 10 years.

The qualitative and quantitative analyses show that ETRs have been significantly higher than predicted by standard analysis over the last decade, and display little response to tax base incentives such as immediate partial expensing of capital expenditure. They also show that when corporations earnings are computed as under US GAAP, ETRs differentials for different types of assets are ultimately negligible. The policy recommendation of this analysis is that changes in statutory tax rates impact on the ETRs far more than temporary variations in the tax base (partial expensing). This recommendation evidently applies within the framework of the neoclassical investment model typically used for the computation of ETRs, which evaluates investment choices at the margin and assumes that firms do not face liquidity constraint. Within this framework, partial expensing generates extra liquidity which firms do not require, and cannot be distributed to shareholders under US GAAP.

The literature on the deferred tax constraint, typified by the works of King (1974), Boadway and Bruce (1979), Sinn (1987) and Kanniainen and Södersten (1995), argues that the constraint is binding if firms finance investment by retained earnings and distribute to shareholders any residual after-tax profit. This paper extends the theoretical findings of this literature, by showing that the impact of the deferred tax constraint goes well beyond the way in which corporations finance investment and distribute profits: the deferred tax constraint has a significant impact on the ETR when investment is financed by retained earnings, new equity and debt; and corporations distribute after-tax profits to individual shareholders through dividends, capital gains or interests. Indeed the deferred tax constraint ultimately reclassifies the saving generated by tax depreciation, treated as a component of earnings in the standard literature, as being indebtedness towards the government. As explained by King (1974), the deferred tax constraint is designed to protect the capital share in the economy: corporations that pass to individual shareholders the saving generated by tax depreciation are ultimately distributing capital, rather than earnings; and the constraint is designed to prevent this from occurring under any financial policy undertaken by corporations.

References

Basu, S. (1997): "The Conservatism Principle and the Asymmetric Timeliness of Earnings," *Journal of Accounting and Economics*, 24, 3–37.

Boadway, R. W. (1980): "Corporate taxation and investment: A synthesis of the neo-classical theory," *Canadian Journal of Economics*, 13, 250–267.

Boadway, R. W., and N. Bruce (1979): "Depreciation and Interest Deductions and the Effect of the Corporation Income Tax on Investment," *Journal of Public Economics*, 11, 93–105.

Burnham, P., and L. Ozanne (2006): "Distortions from Partial Tax Reform Revealed through Effective Tax Rates," *National Tax Journal*, 59, 611–630.

Canova, F. (2007): *Methods for Applied Macroeconomic Research*. Princeton.

CBO (2006): "Computing Effective Tax Rates on Capital Income," *Congressional Budget Office, Washington.*

De Mooij, R., A., and S. Ederveen (2003): "Taxation and Foreign Direct Investment: A Synthesis of Empirical Research," *International Tax and Public Finance*, 10, 673–693.

Easton, P., and J. Pae (2004): "Accounting Conservatism and the Relation Between Returns and Accounting Data," *Review of Accounting Studies*, 9, 495–521.

Givoly, D., C. K. Hayn, and A. Natarajan (2007): "Measuring reporting conservatism," *Accounting Review*, 82, 65–106.

Gravelle, J. G. (1994): *The Economic Effects of Taxing Capital Income.* MIT Press, Cambridge.

Guenther, D., and R. C. Sansing (2000): "Valuation of the firm in the presence of temporary book-tax differences: The role of deferred tax assets and liabilities," *Accounting Review*, 75, 1–12.

Hall, R. E., and D. W. Jorgenson (1967): "Tax Policy and Investment Behavior," *American Economic Review*, 57, 391–414.

Hanlon, M., and T. Shevlin (2005): "Book-Tax Conformity for Corporate Income: An Introduction to the Issues," in *Tax Policy and the Economy Vol. 19*, ed. by J. Poterba, pp. 101–134, Cambridge MA. The MIT Press.

Hassett, K., and G. Hubbard (2002): "Tax Policy and Business Investment," in *Handbook of Public Economics Vol. III*, ed. by A. J. Auerbach, and M. Feldstein, pp. 1293–1343, Amsterdam. Elsevier Science.

Hulten, C. R., and F. C. Wycoff (1981): "The Measurement of Economic Depreciation," in *Depreciation, Inflation, and the Taxation of Income from Capital*, ed. by C. R. Hulten, p. 81Ű125, Washington, D.C. Urban Institute Press.

Jorgenson, D. W. (1963): "Capital Theory and Investment Behavior," *American Economic Review*, 53, 247–259.

Kanniainen, V., and J. Södersten (1995): "The Importance of Reporting Conventions for the Theory of Corporate Taxation," *Journal of Public Economics*, 57, 417–430.

King, M. A. (1974): "Taxation and the Cost of Capital," *Review of Economic Studies*, 41, 21–35.

King, M. A., and D. Fullerton (1984): *The Taxation of Income from Capital: A Comparative Study of the United States, the United Kingdom, Sweden and West*

Germany. University of Chicago Press, Chicago.

Korinek, K., and J. E. Stiglitz (2009): "Dividend taxation and intertemporal tax arbitrage," *Journal of Public Economics*, 93, 142Ű159.

Mills, L. F. (2006): "Five Things Economists and Lawyers Can Learn from Accountants: An Illustration Using the Domestic Production Activities Deduction," *National Tax Journal*, 59, 585–597.

Mills, L. F., and G. Plesko (2003): "Bridging the Reporting Gap: A Proposal for More Informative Reconciling of Book and Tax Income," *National Tax Journal*, 56, 865–893.

Plesko, G. A. (2006): "Multidisciplinary Issues in Corporate Tax Policy," *National Tax Journal*, 59, 599–610.

Polito, V. (2009): "Measuring the Effective Tax Burden in the Real World," *Fiscal Studies*, 30, 247–278.

Poterba, J., N. Rao, and J. Seidman (2011): "Temporary Differences, Deferred Tax Positions, and Corporate Incentives," *National Tax Journal, forthcoming.*

Sansing, R. C. (1998): "Valuing the deferred tax liability," *Journal of Accounting Research*, 36, 357–363.

Sinn, H.-W. (1987): *Capital Income Taxation and Resource Allocation*. North-Holland, Amsterdam.

Sørensen, P. B. (1995): "Changing Views of the Corporate Income Tax," *National Tax Journal*, 48, 279–294.

A Appendix 1: Deferred taxes and corporation earnings under the temporary difference approach

This appendix illustrates the basic principles of accounting for deferred taxes under the temporary difference approach using the example of a firm purchasing an asset worth $1000 which depreciates on a straight-line basis at the 20 per cent rate for financial reporting and on a straight-line basis at 25 per cent for tax purposes. As shown in Table 6, in each year the difference between the value of the asset for book and tax accounting determines the temporary difference, reported in the penultimate column. The corresponding capital provision for deferred taxes is calculated in the last column, as the product between the statutory tax rate (35 per cent) and the temporary difference: the value of the provision therefore increases in the first four years as tax depreciation exceeds book depreciation, whereas it reduces in the last year since tax depreciations have been claimed in full but the firm still claims depreciation for financial reporting. In this example the firm sets a deferred tax liability in the balance sheet to adjust for the fact that tax depreciation is deductible faster than book depreciation. Hence the firm is postponing tax payments to the future. In contrast, the firm would record a deferred tax asset in its balance sheet if tax depreciation were deducted slower than book depreciation, to account for the earlier tax charge.

TABLE 6: DEFERRED TAXES ACCOUNTING, BALANCE SHEET

Year	Depreciation		Asset value		Temporary	Deferred Tax
	Book	Tax	Book	Tax	Difference	provision
0	0	0	1000	1000	0	0
1	200	250	800	750	50	17.5
2	200	250	600	500	100	35
3	200	250	400	250	150	52.5
4	200	250	200	0	200	70
5	200	0	0	0	0	0

Note: Initial asset value is $1000; statutory tax rate is 35 per cent.
Source: Author's calculations

Table 7 illustrates how deferred taxes are charged on the income statement. It is assumed that the book value of pre-tax earnings before depreciation is $300. The deferred tax charge in each period corresponds to the change in the provision for deferred taxes relative to the previous year (last column, Table 6): this is positive and increases the total tax liability in the first four year, whereas it is negative and reduces the total tax liability in the last year. The table therefore illustrates the effect of accounting for deferred taxation on corporate earnings: the after tax profit ($65) equals the pre-tax earning ($300) minus book depreciation ($200) and the tax rate on book profit (0.35×100=35): In other words, corporation earnings available for distribution to shareholders are unaffected by the gap between book and tax income.

TABLE 7: DEFERRED TAXES ACCOUNTING, INCOME STATEMENT

Year	Pre-tax earning	Depreciation Book	Depreciation Tax	Tax base	Current tax	DTC	Total tax	After-tax earning
0	0	0	0	0	0	0	0	0
1	300	200	250	50	17.5	17.5	35	65
2	300	200	250	50	17.5	17.5	35	65
3	300	200	250	50	17.5	17.5	35	65
4	300	200	250	50	17.5	17.5	35	65
5	300	200	0	300	105	-70	35	65

Note: Pre-tax earning is gross of book depreciation; DTC=Deferred tax charge; statutory tax rate is 35 per cent.
Source: Author's calculations

Table 8 illustrates the after-tax earnings computation under deferred taxation with re-investment. It is assumed that the firm invest the liquidity generated by deferred taxation in a bank account earning a 10 per cent pre-tax rate of return and this financial return is part of corporate tax profits and taxed under the statutory tax rate. After-tax earning therefore increases in the first four periods in line with the after-tax return from the financial investment of resources in provision for deferred taxes.

B Appendix 2: The model

The model considers a competitive firm, initially ($t = -1$) capitalized with k_{-1} dollars of equity, making investment expenditure in fixed assets in period $t = 0$. The change in the replacement cost of the capital base for economic, accounting and tax

TABLE 8: DEFERRED TAXES ACCOUNTING WITH RE-INVESTMENT, INCOME STATEMENT								
Year	Pre-tax earning	Return on DTC	TD	Tax base	Current tax	DTC	Total tax	After-tax earning
0	0	0	0	0	0	0	0	0
1	300	1.75	250	51.75	18.11	17.5	35.61	66.14
2	300	3.5	250	53.5	18.72	17.5	36.22	67.27
3	300	5.25	250	55.25	19.34	17.5	36.83	68.41
4	300	7	250	57	19.95	17.5	37.45	69.55
5	300	0	0	300	105	-70	35	65

Note: Pre-tax interest rate on provisions for deferred taxes is 10 per cent; DTC=Deferred tax charge; TD=Tax depreciation; the tax rate is 35 per cent.
Source: Author's calculations

purposes are described respectively by

$$k_t = x_t + (1 - \delta)\, k_{t-1} \tag{11}$$

$$k_t^{\alpha} = x_t + (1 - \alpha)\, k_{t-1}^{\alpha} \tag{12}$$

$$k_t^{\phi} = x_t + (1 - \phi)\, k_{t-1}^{\phi} \tag{13}$$

where x_t is gross investment, k_t is the stock of capital in period t, k_t^{α} and k_t^{ϕ} are the values of the capital stock for book and tax purposes respectively, δ is the rate of physical depreciation, α is the rate of accounting depreciation and ϕ the tax depreciation rate. It is assumed that $k_{-1} = k_{-1}^{\alpha} = k_{-1}^{\phi}$.

Deferred taxes measure future tax liabilities (if positive) or assets (if negative) resulting from the difference between the carrying amount of assets or liabilities recognized in the balance sheet and their corresponding amount attributed for tax purposes (temporary difference). Under US GAAP, this implies that the firm must set a provision P_t for any deferred tax assets and liability arising in period t. The provision is equal to the tax rate on the difference between the accounting and the tax value of the capital stock. In other words, the value of provisions for deferred taxes accumulated up to period t is given by

$$P_t = u\left(k_t^a - k_t^{\phi}\right), \tag{14}$$

while the present value of provisions for deferred taxes per unit of investment

$$p_t = u\left(z_{\phi} - z_{\alpha}\right), \tag{15}$$

where $z_s = \frac{s}{1+r_c-\pi}\sum_{j=0}^{\infty}\left(\frac{1-s}{1+r_c-\pi}\right)^j = \frac{s}{s+r_c-\pi}$, with $s = \phi, \alpha$ denoting present values of depreciation allowances for book ($s = \alpha$) and tax ($s = \phi$) purposes implied by equations (12) and (13), r_c is the nominal discount rate and π is the inflation rate. Notice how $p_t \gtreqless 0$ if $\phi \gtreqless \alpha$.

Provisions for deferred taxes give rise to extra financial resources which - in equilibrium - can be invested in the financial market at the nominal rate. Therefore, the profit function of the firm in any period t is written as

$$\Pi_t = f\left(k_{t-1}\right) - r_c b_{t-1} + r_c P_{t-1}, \tag{16}$$

where $f\left(k_{t-1}\right)$ is a standard neoclassical production function with constant return to scale in both factors and: $f\left(0,0\right) = 0$, $f_k > 0$, $f_{kk} < 0$, $f_n > 0$, $f_{nn} < 0$.

The firm's total tax liability, u_t^T, is given by the sum of current, u_t^C, and deferred, u_t^D, tax liabilities. Current tax liabilities are in general written as

$$u_t^C = u\left[f\left(k_{t-1}\right) - r_c b_{t-1} + r_c P_{t-1} - \phi x_t\right]. \tag{17}$$

Deferred tax liabilities in any period t correspond to the change in the value of provisions for deferred tax over the same period of time, equivalent to the tax rate on the difference between tax and accounting depreciation

$$u_t^D = \Delta P_t = u\left(\phi k_t^{\phi} - a k_t^{a}\right). \tag{18}$$

Notice that $u_t^D > 0$ measures a deferred tax liability, whereas $u_t^D < 0$ measures a deferred tax asset: the former increases the stock of provisions for deferred taxes, the latter reduce it.

Divided income distributable to shareholders is computed from the accounting identity between sources and uses of income

$$\Pi_t + \Delta b_t = d_t + u_t^T + x_t. \tag{19}$$

The left hand side includes retained profits or change in the stock of debt, whereas the right hand side includes dividend payments (d_t), taxes and new investment.

Subject to the constraints from (11) to (19), and the starting values of k_{-1}, b_{-1} and P_{t-1}, the firm maximizes the expected present value of dividend income distributable to shareholders

$$V_0 = E_0 \sum_{t=0}^{\infty} \left(\frac{1}{1 + r_c - \pi}\right)^t d_t, \tag{20}$$

where E_0 denotes mathematical expectations. The first order condition with respect to the stock of capital yields the before-tax real rate return required for a marginal investment in equation (1).